Contract Report CADD-98-1
January 1998

Tri-Service CADD/GIS Technology Center

Implementation of the Tri-Service Workspace for AutoCAD Users

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Contents

Preface

This report presents the Tri-Service requirement for customized interfaces in AutoCAD and shows the implementation of the "workspace" concept in AutoCAD. Authors of the report are Dr. Doris S. Shaw, Ms. Sara E. Ort, Ms. Katherine R. Millburg, and Mr. Jerry M. Lagrou, all of the U.S. Army Construction Engineering Research Laboratories (USACERL).

The work was performed by the Engineering Processes Division, Dr. Michael P. Case, Chief, Planning and Management Laboratory (PL), and Mr. L. Michael Golish, Operations Chief, USACERL. The USACERL technical editor was Ms. Linda L. Wheatley, Technical Information Team. Dr. Michael J. O'Connor was Director of USACERL. COL James A. Walter was Commander.

The study was conducted for the Tri-Service Computer-Aided Design and Drafting/Geographic Information System (CADD/GIS) Technology Center. The project manager was Mr. James T. Wilson of the U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS. Mr. Harold L. Smith was the Chief of the CADD/GIS Technology Center which is located in the Information Technology Laboratory (ITL) at WES. The Director of ITL was Dr. N. Radhakrishnan.

The Director of WES was Dr. Robert W. Whalin. The Commander was COL Robin R. Cababa, EN.

1 Introduction

The term "workspace" describes a set of customized Computer Aided Design and Drafting (CADD) environments. These environments are designed for users in the specific architectural and engineering disciplines to accomplish their specialized tasks more easily. Not only does the workspace provide convenient tools, it configures the CADD commands so that entries to the design file automatically comply with the Tri-Service Architectural, Engineering, Construction (A/E/C) CADD Standards.

The importance of complying with A/E/C CADD standards in CADD drawings cannot be overemphasized. Automation has changed and extended the drafting board beyond anything imagined just a few years ago. Using previous work of one's own or that of others is now simple and efficient. Processes that once required days of comparisons and calculations can be done now in a few hours or minutes. The time savings gained from such operations depend on being able to interpret the graphic data contained in CADD files, which, in turn, depends on graphic standardization.

Using the A/E/C CADD Standards allows work to be done in a cooperative design environment. Developing a facility design document was largely an individual (or small team) effort in the past. Today, collaborating with scores of experts and specialists is possible if all participants use the same standards. Users can reference solutions to problems similar to their own, borrow and modify drawings from libraries, and reuse bits and pieces to create new designs with little effort. Bids can be submitted electronically using standardized CADD files, and customers will be able to compare requirements equitably across submissions.

The success of all these efforts depends on using the knowledge, not just the picture, contained in the design file. If a magenta figure appears on a layer named "C-SITE-WALK" (or a number corresponding to that name), there can be little doubt as to what that figure means. To answer the question of how much gravel will be needed for that walk, users need only to calculate the area or automate the calculation. In a similar way, the design file contains the meaning of each element in the file and can make that information available to users.

Of course, all interested parties must agree on the meanings in order for such intelligence and sharing to work. Dictionaries help us communicate by establishing standard meanings and spellings for words. The A/E/C CADD Standards have been established to meet the goal of communication within the Tri-Services. Like standards for words, graphic

standards will change in form and meaning over time, but the current standard must be observed if we are to gain the rewards of CADD. Also like verbal standards, it is difficult to keep the current graphic standards in mind. Assistance, similar to a word processing spell checker, can be very useful in a workspace.

Background

Several years ago, the workspace concept was developed by the MicroStation CADD developers. The idea was to create a tailored environment (within a comprehensive CADD system) wherein a user could carry out frequently performed tasks very easily and, therefore, become more productive. Variations of that idea have been common for many years. Almost every experienced CADD user has created a few shortcuts. To construct the Tri-Service Workspace (TSWS) for MicroStation, government CADD users in several different disciplines determined which tasks they frequently performed and would like to simplify. Seven Architectural and Engineering disciplines are presently represented: Architectural, Civil, Electrical, Environmental, Mapping, Mechanical, and Structural. Palettes of command icons were prepared that made it easy to select and enter discipline-specific entities in a drawing. Each discipline has its own icon palette that keeps the number of choices small and simplifies element entry.

An extremely significant component of the MicroStation TSWS is the standard setting feature. One of the most difficult aspects of entering elements in a drawing is placing them on the correct level with line types and colors according to CADD standards. Because the command buttons on the palettes can be set to a particular level, color, and line style, entry is greatly simplified by using a pre-set button on an icon palette.

The Tri-Service CADD/GIS Technology Center (TSTC) serves many AutoCAD users, as well as MicroStation users. In 1996, USACERL investigated the workspace concept and implementation for AutoCAD. The investigation began with a study of the user interface. While there are many other features in the MicroStation TSWS, the simple and intuitive special discipline interfaces are a great strength. Researchers felt that the AutoCAD TSWS should duplicate the MicroStation special discipline interfaces to make standard element entry simple. As CADD users work with a variety of customers with specialized requirements, they may be required to switch from one system to another for particular projects. Being fluent in both AutoCAD and MicroStation becomes more important as collaboration becomes more common. If the two workspaces have the same look and feel, it should be more comfortable to change from one to the other and data, strategies, documentation, and training can be shared more easily.

As AutoCAD users were interviewed, an important fact became apparent. Many third-party and self-developed applications are used with AutoCAD that are very popular with the users — many more than were found with MicroStation. It is unlikely that users will willingly change from familiar and well-liked applications to a new one offered in the AutoCAD TSWS, just to meet the TSS requirement. It is essential that users be able to use any desired application with AutoCAD while receiving help in complying with the TSS. Because of this constraint, the interface and the standards compliance mechanism must be viewed separately for the AutoCAD TSWS.

Objective

The objective of this project was to implement a workspace environment in AutoCAD resembling the one developed for MicroStation (through the efforts of the TSTC). In both CADD systems, TSWS provides an environment to facilitate the production of CADD documents that comply with the Tri-Service graphic standards. The AutoCAD TSWS must consider any special requirements that may not apply to the MicroStation TSWS.

Scope

The 1996 user study (Shaw, Lagrou, and Millburg, 1997) established functional requirements for the AutoCAD workspace. Other requirements evolved from further study and consultation. These requirements fall into two sections, the interface and the standards support. Development of these designs was the focus of this work.

The Interface

The interface design:

- must be intuitive to use
- must make productive work easier in each discipline
- should function in predictable ways for AutoCAD users
- should be similar to the MicroStation workspace so that data, strategies, documentation, and training can be shared.

The TSWS Standards Support

The standards support design:

- must be a reliable source for the current TSS
- must include all of the standards information presented in the "A/E/C CADD Standards Manual"
- must be easy to update to new standards
- should have standard settings and symbols should be independent from the user interface so that any user who creates a customized application is able to apply the current TSS by running both the application and the TSWS
- should provide a mechanism to notify workspace users if they enter nonstandard elements into their files through software or user interaction, and the program should offer assistance to bring the files into compliance.
- should provide assistance for the resolution of conflicts in standards settings to third-party developers who desire to support TSS.

Implementation of an AutoCAD TSWS to meet the above functional requirements is in progress and will be described in the next two chapters. A demonstration of the TSWS can be viewed from your network browser in a Video Clip. The location of the demonstration can be found on the Tri-Service Center's Home Page, http://TSC.wes.army.mil/.

2 The Interface Design

The general plan for the Interface Design follows the pattern of the MicroStation TSWS. The Tri-Service AutoCAD workspace automatically loads the TSWS partial menu into the main AutoCAD menu bar, Figure 1. The TSWS pull-down menu lists the seven disciplines and the check routines. The only special discipline toolbar presently linked to the workspace is Civil Engineering. At least two more toolbars will be completed before the program testing. The check feature will be discussed as a part of the standards support system.

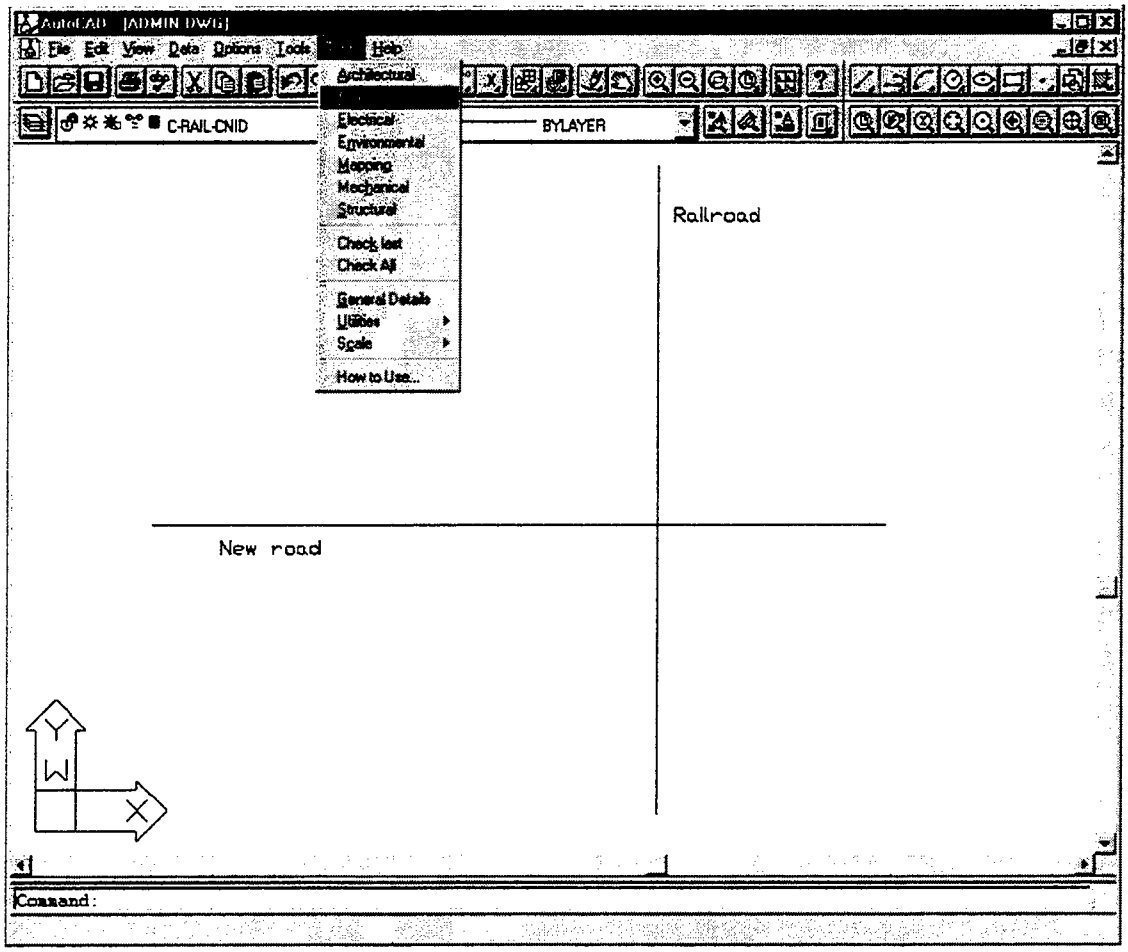

Figure 1. Tri-Service Workspace pull-down menu.

The main Civil Engineering toolbar has seven icons, each of which has a flyout menu. Button help is available for each icon, and a command description appears at the bottom of the window. The 28 icons in the Civil Engineering interface call corresponding AutoLisp

routines that control the dialog boxes and command actions. When an icon is selected, the correct command and layer are set, and the entity may be drawn in the file.

Figure 2 shows the flyouts for the Civil toolbar. The Civil toolbar appears in the center panel. The flyouts for each icon are on the sides. The main flyout icon from the center panel is repeated at the start of each row.

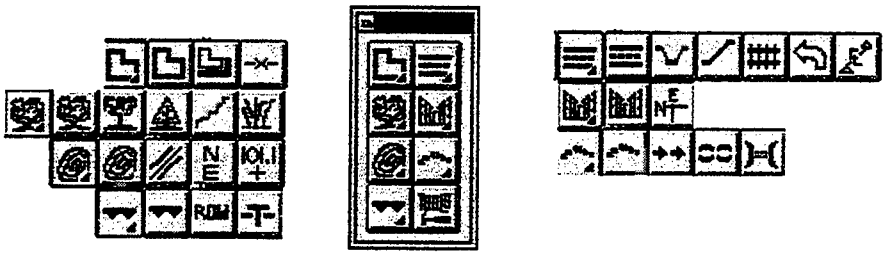

Figure 2. Civil Engineering Toolbar and Flyouts

Reading from the top left, the icons are:

- Building, Walks, Fence
- Shrub, Deciduous Tree, Coniferous Tree, Tree Line, Turf
- Contours, Break Lines, NE Labels, Spot Elevations
- Slope, Row, Utilities

The icons on the right are:

- Roads, Channel, Embankments, Rail Roads, Markings, Alignment
- Cross Sections, Coordinate Lines
- Ditch, Flow, Rip Rap, Culvert
- Civil Engineering Tools

Figure 3 shows the Civil Engineering toolbar and Roads flyout in AutoCAD.

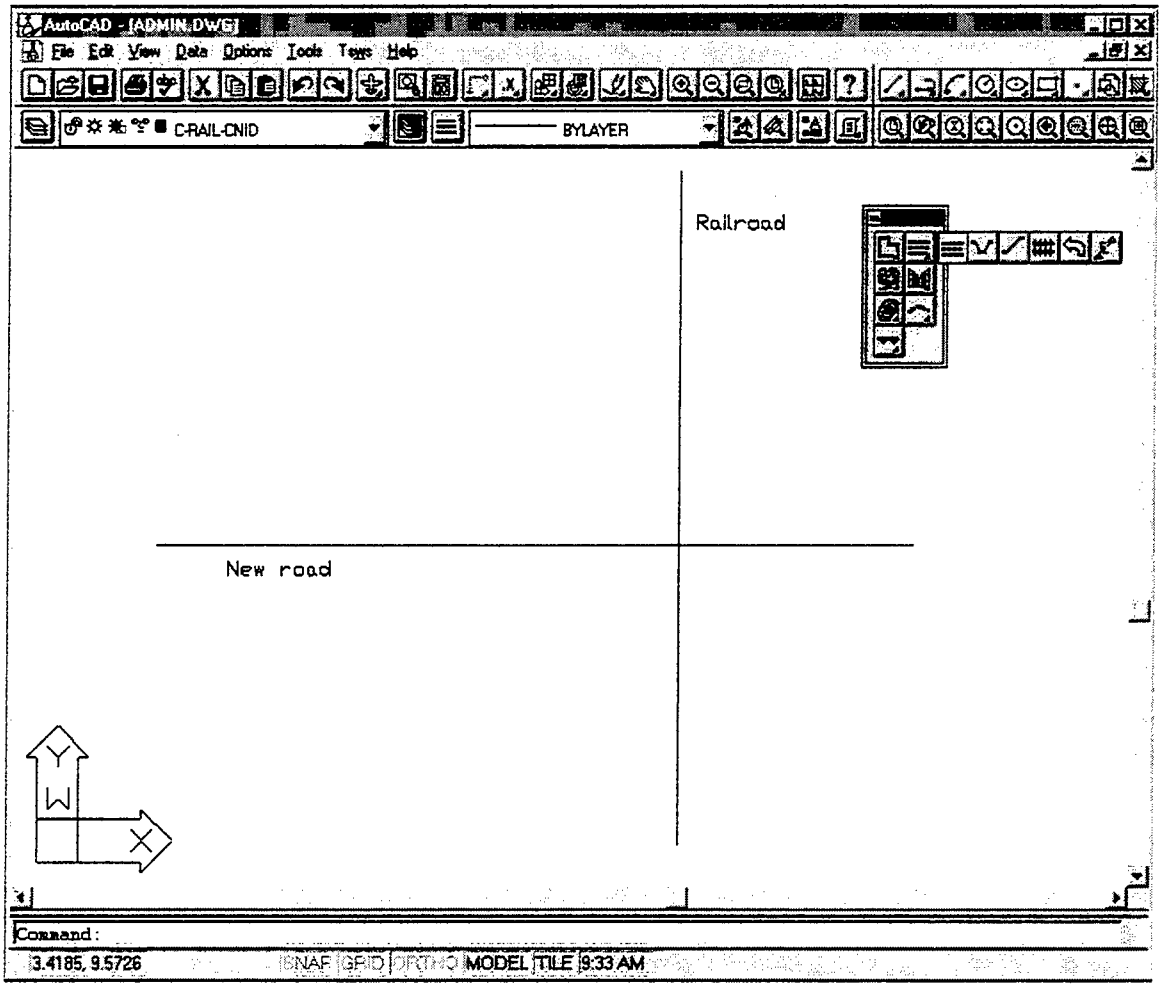

Figure 3. Civil Engineering Toolbar with Roads Flyout

The AutoCAD Civil icons bring up appropriate dialog boxes and commands. Many of the dialog boxes offer choices about the object being placed, such as edge or center, or the type of object, such as walk or trail. Some of the dialog boxes offer the option to annotate. When annotation is selected, a text box is provided. All of the choices select the correct layer settings and call the appropriate command.

Figure 4 shows the dialog box for walks. Walks, Trails, or Curbs can be selected from the Item pulldown. Select Object or Annotate from Type. The object or text will be drawn on the correct standard layer, with the correct standard linetype and color.

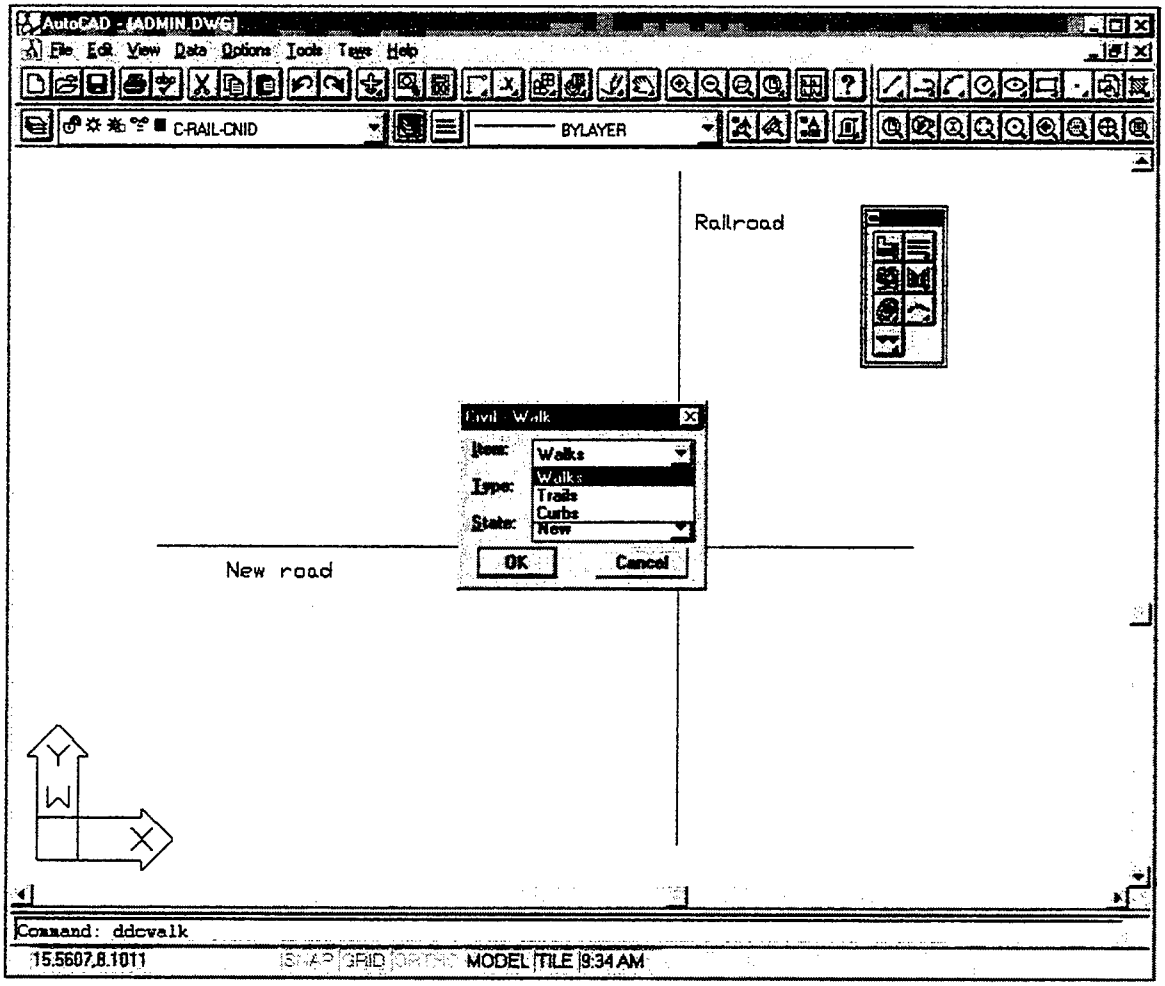

Figure 4. Dialog Box for drawing or annotating a walk, trail or curb.

The use of these icons for the appropriate entries in the drawing greatly simplifies the work. Entries other than the ones available from the icons may be made either from the AutoCAD menus, type-ins, or other software. All entries may be checked for standards compliance.

3 The Standards Support Design

The Standards Support Design should be considered separately from the tools provided by the special discipline interfaces. The 1996 user study revealed that many users thought they were accessing the current standards, but they actually were not. The requirements that the workspace be a reliable source for the current TSS and that it include all of the necessary standards information suggest that a link be established with the repository data for those standards. Downloading the complete TSS files to each user is not feasible because of the file size. Also, the format of the data files would be difficult for users to reference. Users have commented on the difficulty of locating information in the very large files on the TSTC's A/E/C CADD Standards CD-ROM (and those may become outdated). The first challenge was to find a way to efficiently download the current TSS to each user in a form usable for the creation of new drawings and to check existing drawings.

The program currently writes a much smaller LISP file (under 1 megabyte), which contains all the necessary information to automate file creation and checking programs. The system must also load the necessary symbols and details libraries for standards support. Named the Standards Core Information File (SCIF), it can be created at the site of the Standards Data Source files (currently at the Tri-Service Center) and downloaded by users through an FTP[1] site. Whenever a change in standards occurs, running that program once would update the SCIF. If there is a change in the format of the Standards Data Source files, a new conversion program would be required to transfer the information to the SCIF format, which is the only maintenance foreseen to be needed to sustain the system.

Once the workspace program is loaded, any features on the pull-down menu may be used, which includes the single discipline toolbars and the standards checker. AutoCAD commands or any other AutoCAD software tools may be used also. If the data entry system is preset to a nonstandard setting, file checking is still available. Developers should remember that if layer names are in agreement with the standards, the color and line type will be set automatically by the workspace and need not be individually set by the tool software. Any other settings made by tool software would not be affected by the standards support system. Figure 5 shows a plan for the standards support system. Individual sections will be shown and discussed separately through the remainder of this chapter. Refer to Figure 6 to see how the sections fit into the total plan.

[1] FTP = file transfer protocol.

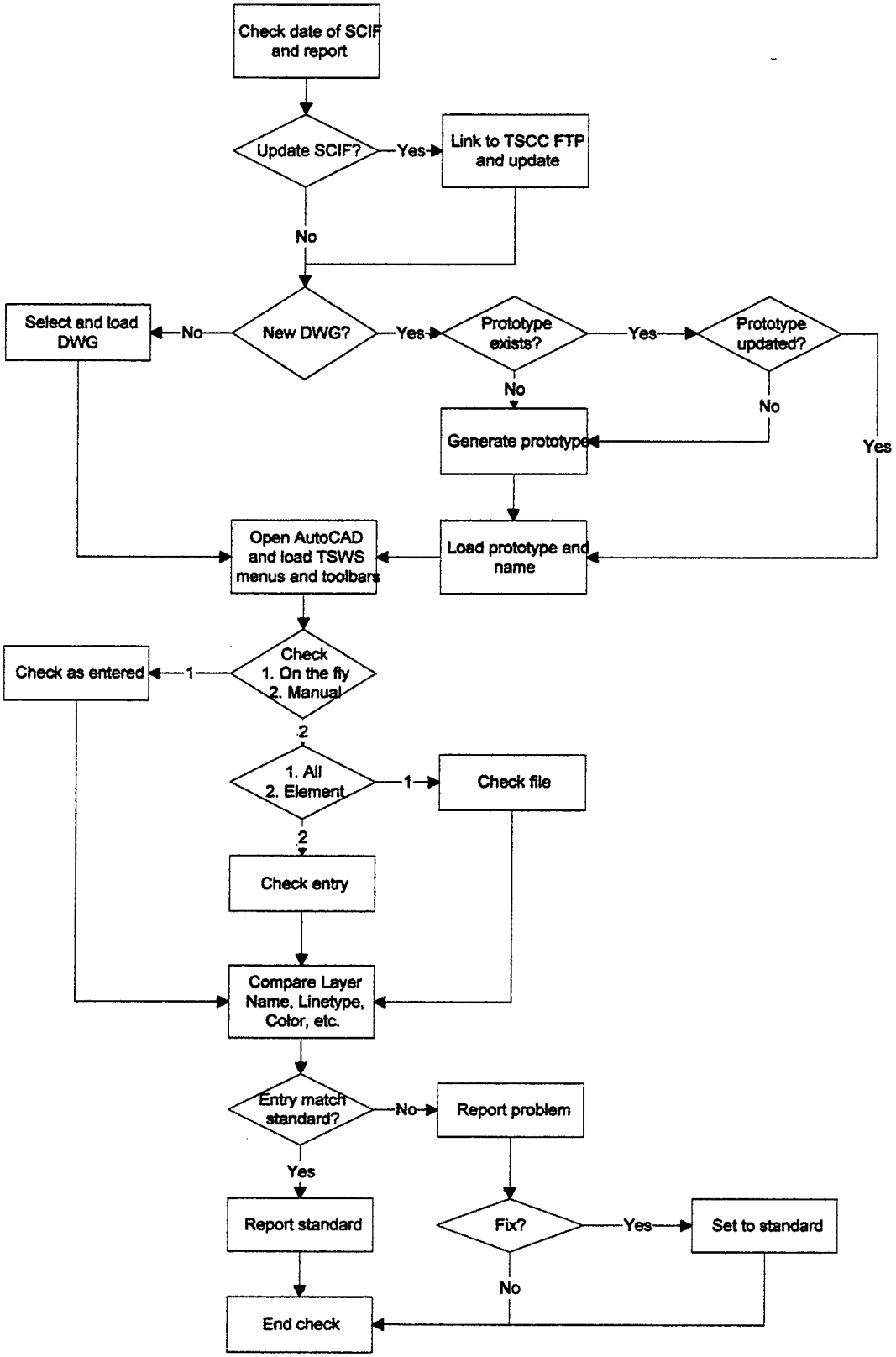

Figure 5. Flowchart for Standards Support System

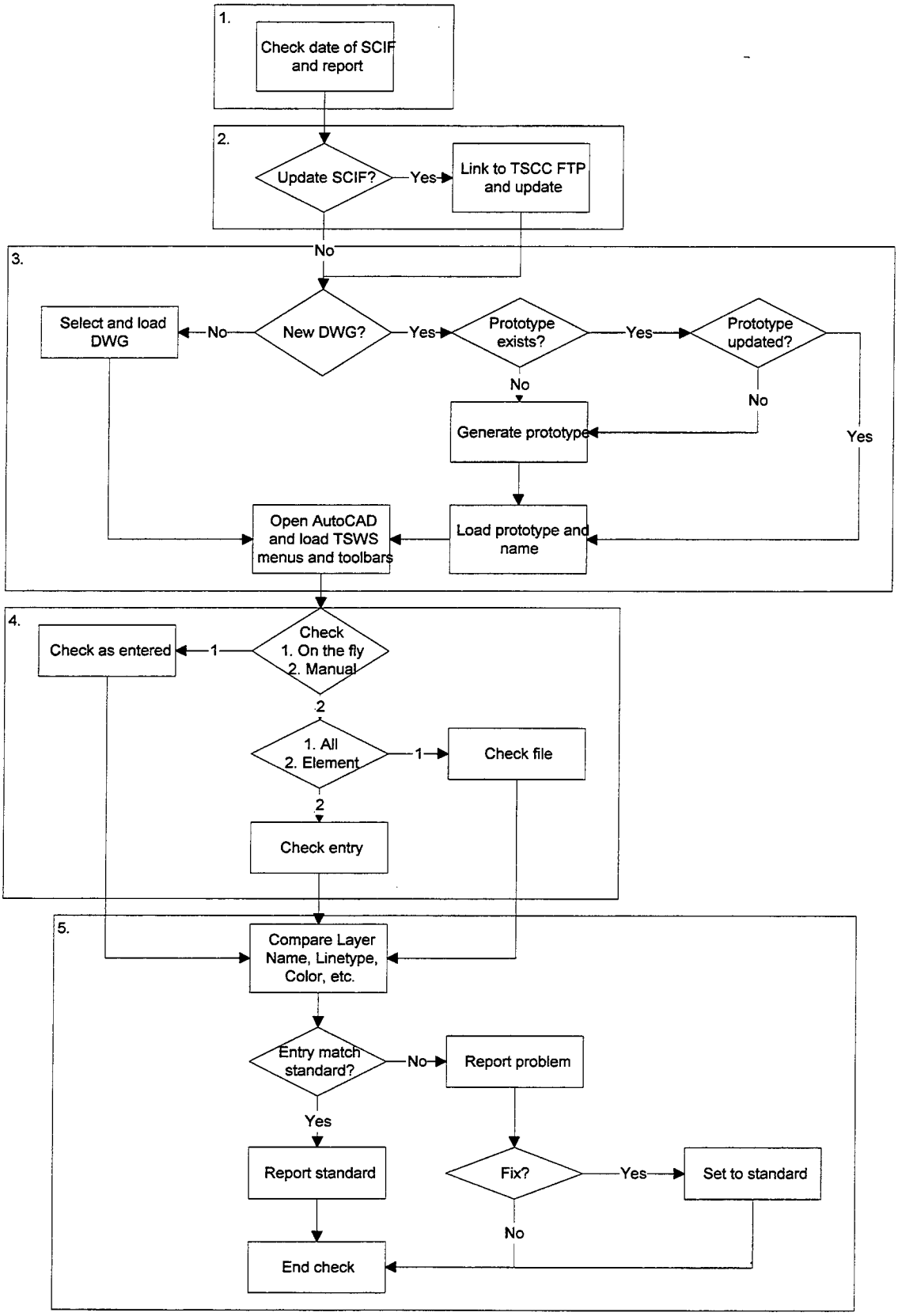

Figure 6. Flowchart Sections

In the directory that users will download from the TSTC, will be an Installation program which provides:

- the Workspace Program
- the ACAD TSWS Startup Icon
- the SCIF.

A Standard Prototype DWG file will be generated on the computer the first time the user asks for a new drawing. Clicking on the icon starts the program. As shown in Figure 7, the first action of the program is to report the date of the SCIF. Check to see if the date is the current date or the date of the most recent TSS update.

Figure 8 shows the important link to the TSCC. If uncertain that the date of the SCIF is the most recent one, the user should link to the FTP site and update his/her file. This step is the safest way to ensure compliance with the current standard. Users will be able to download the most recent SCIF without re-installing the program.

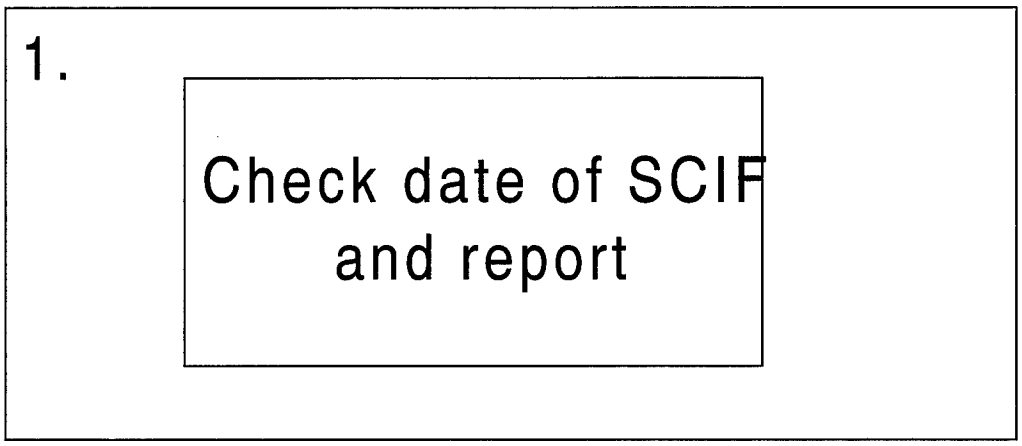

Figure 7. Check and Report

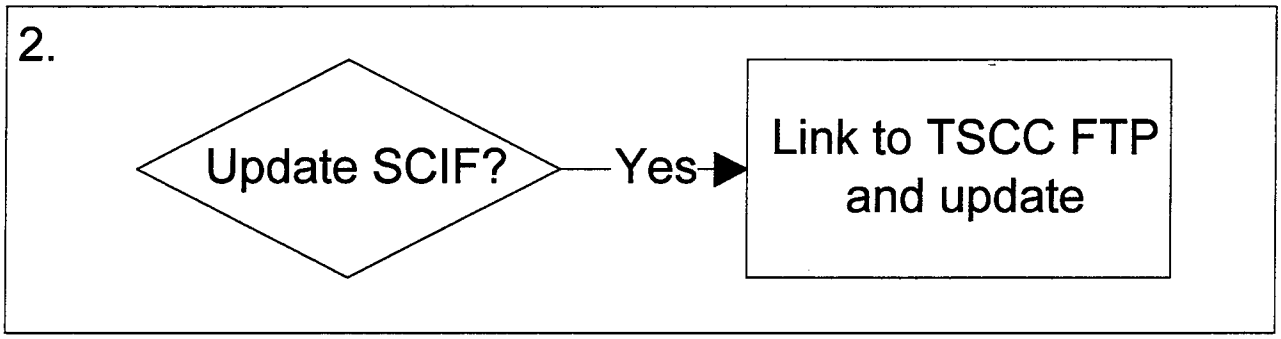

Figure 8. Update Prompt and Access to TSCC FTP

Users may choose to load an existing drawing or create a new one, as shown in Figure 9. When a new drawing is chosen, the computer will decide how to accomplish it. If the computer does not have a Standard Prototype available, the program will generate and load one. If the computer has a Standard Prototype, the program will compare its date with the date of the user's SCIF. If they match, the Standard Prototype will be loaded. If the SCIF is more recent, a new prototype will be generated and loaded. The prototype will be loaded into AutoCAD, and the user will be prompted to name the file according to TSS naming conventions.

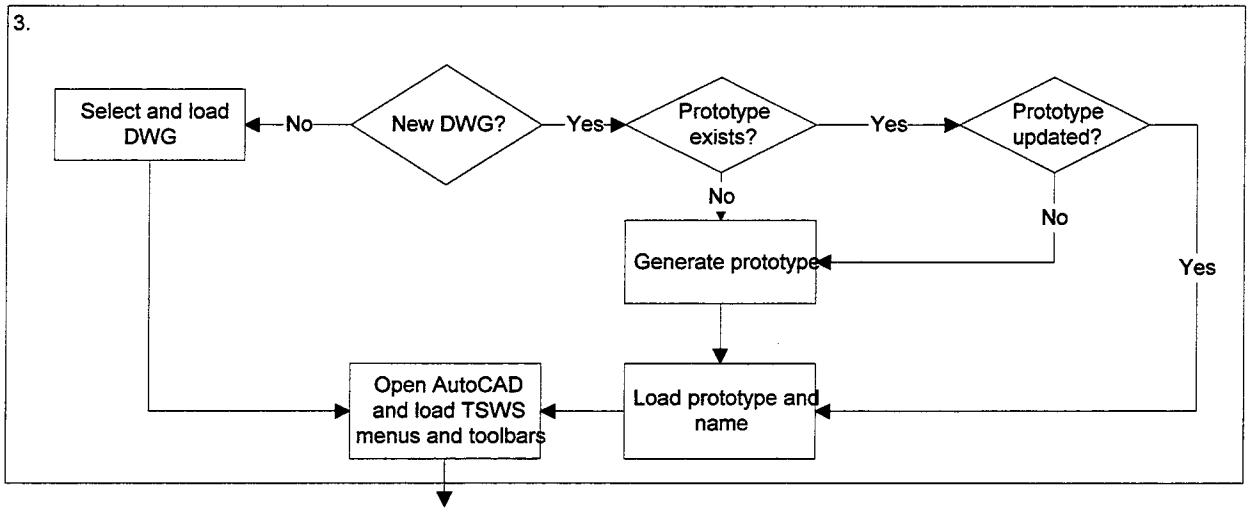

Figure 9. New or Existing Drawing

Shown in Figure 10 are options for the Standards Check on the TSWS pull-down menu, Figure 1. If the user chooses to check on the fly, the program will run the checker, Figure 11, on each entry as he/she works. If nonstandard elements are found, a notification

flag will be set, and the user can choose to open a dialog box immediately to deal with the problem or to turn the flag off. The user may choose to check the last entry, a selected entity, or to check the whole file. When possible, there will be options for a complete file check (i.e., to print a report or to standardize nonstandard elements).

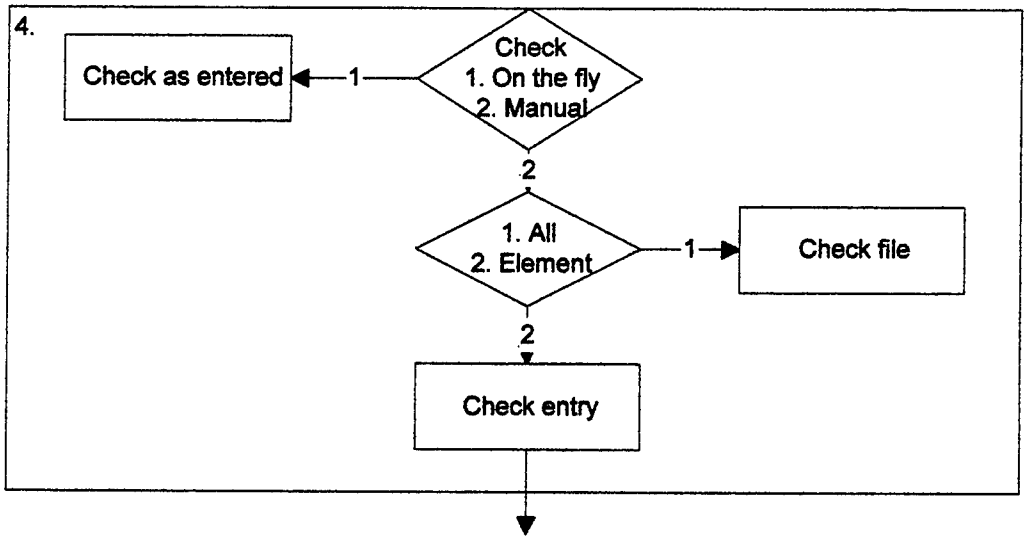

Figure 10. Check Choices

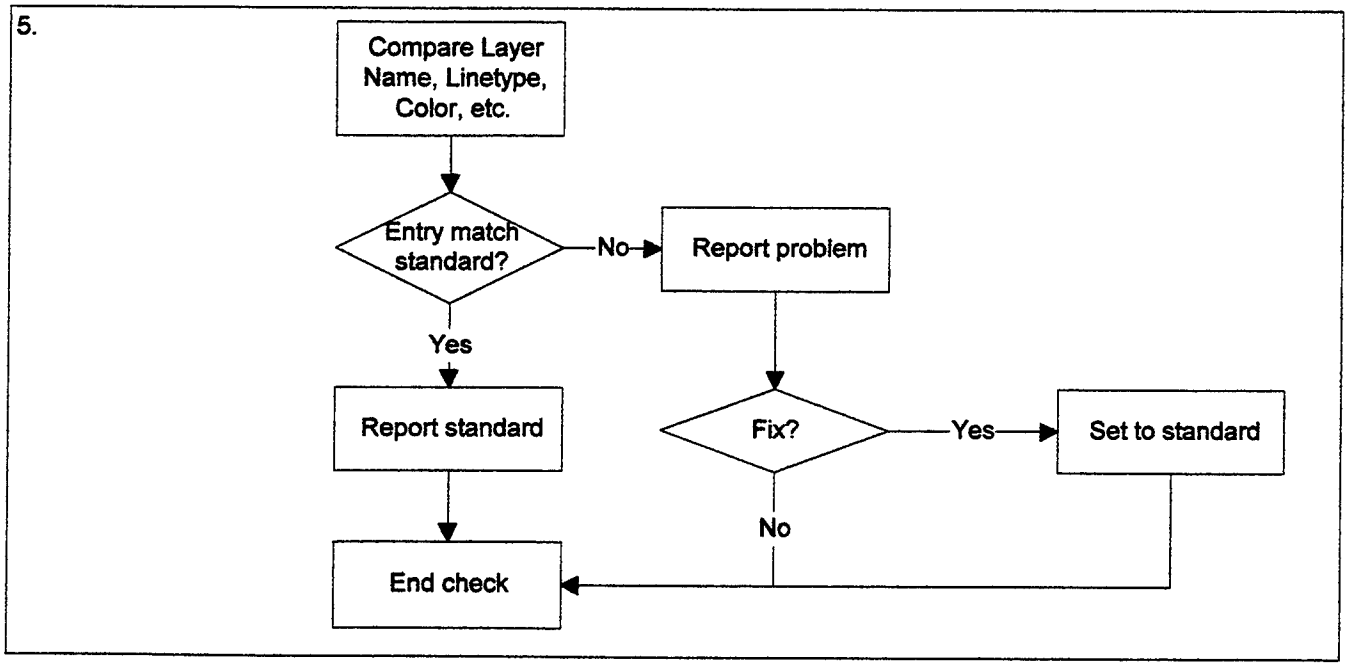

Figure 11. The Checking System

The checker works by comparing an element with the SCIF. If the information matches, the program will report that it meets the standard, Figure 12.

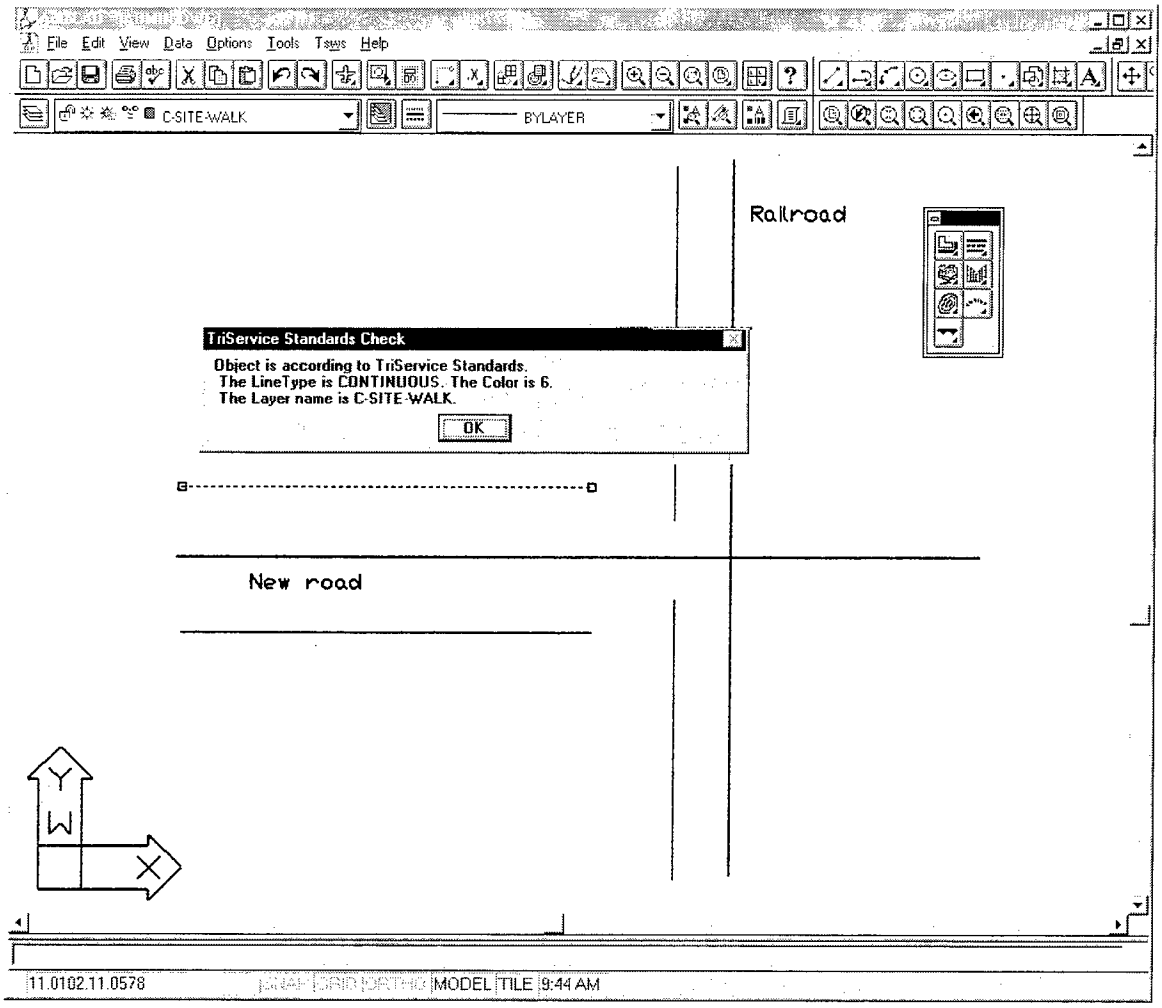

Figure 12. The selected walk meets the standards.

If it does not match, the checker will report how it differs. The report will appear in a dialog box on the check entry option. In the future, mismatches can be flagged, a list printed, and errors fixed at the users discretion. Figure 13 through 15 show the non-standard problems.

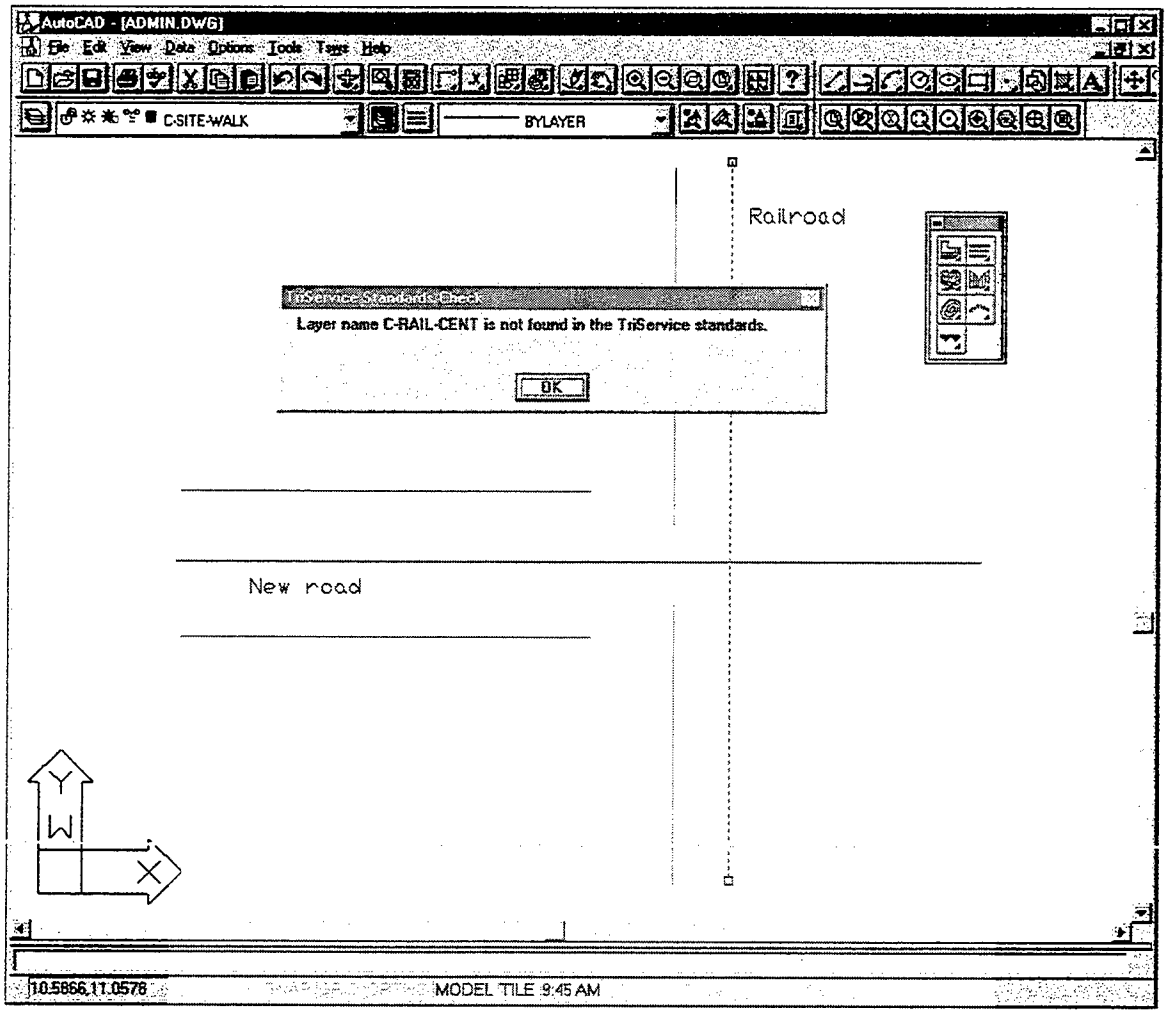

Figure 13. C-RAIL-CENT is not a standard layer name.

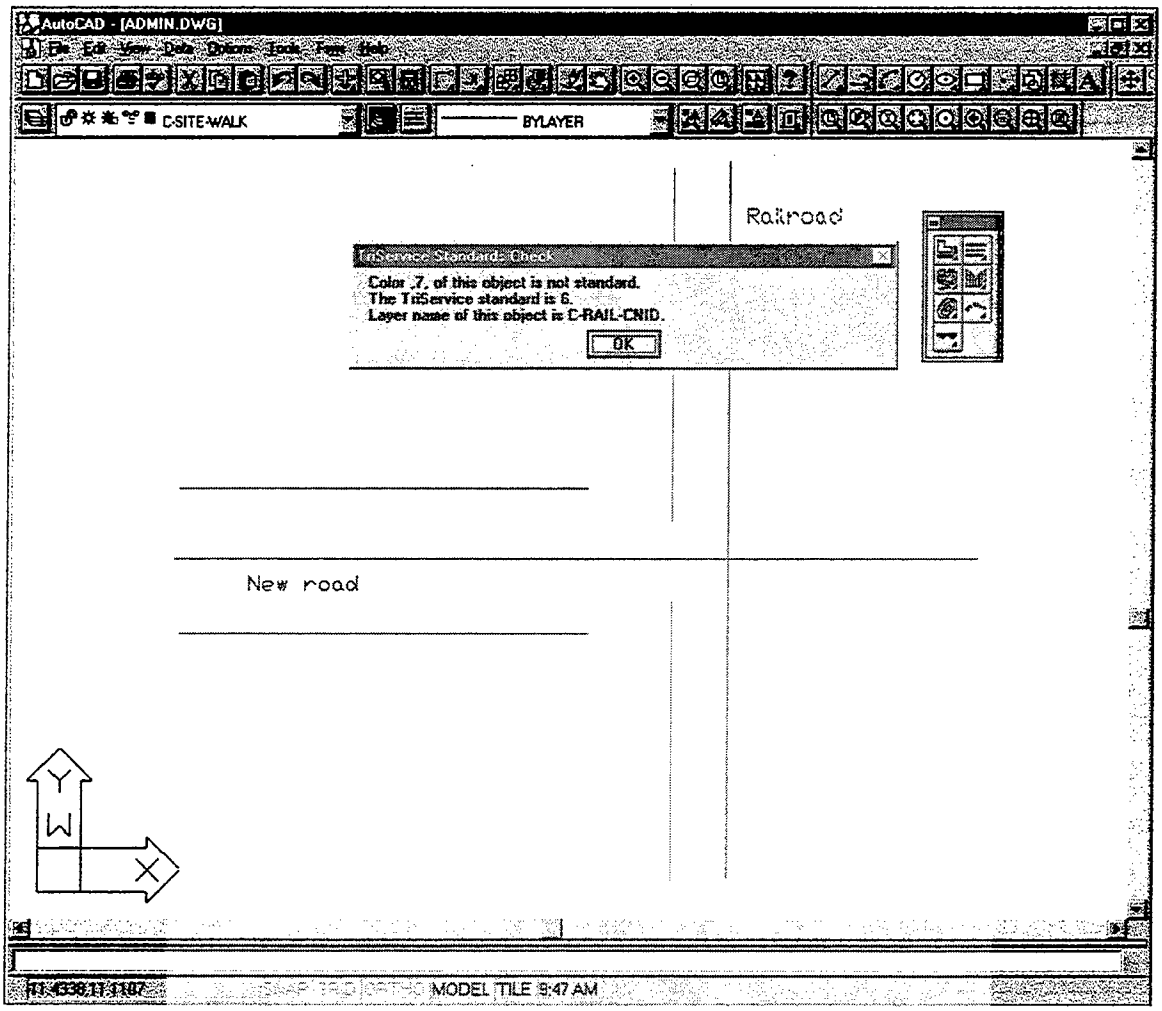

Figure 14. Black is not the standard color for a railroad annotation.

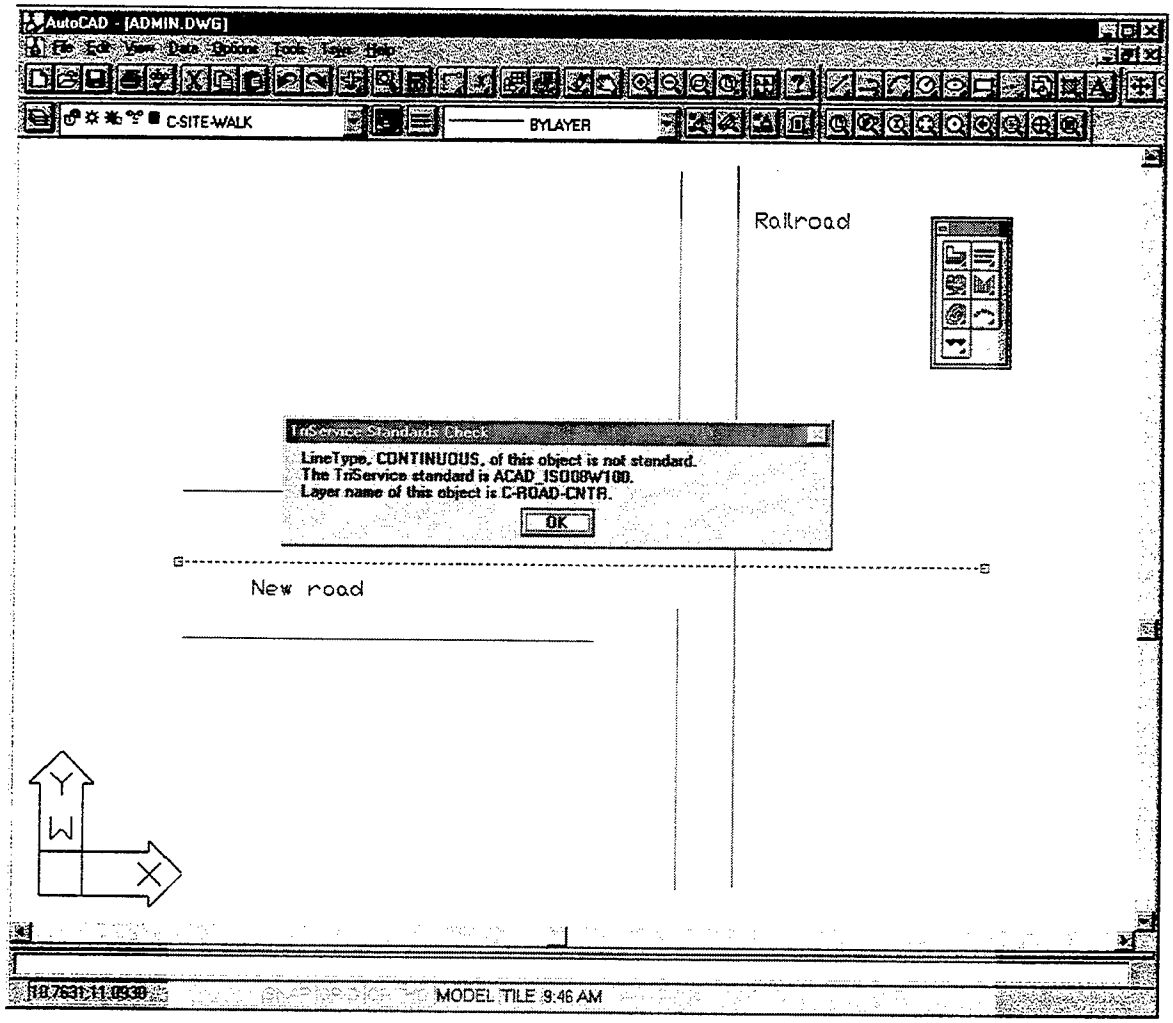

Figure 15. The selected road was drawn before the TSWS was available.

4 Recommendations and Conclusions

Recommendations

Several special discipline toolbars should be completed following the MicroStation TSWS model as soon as that model is available. Testing the standards support system with users who use and who do not use third-party AutoCAD tools must be carried out to determine the effectiveness of the system for preparing standard documents. Any indicated revisions or enhancements should be implemented. USACERL plans to test the use of the AutoCAD TSWS with the CE-CADD product developed by the U.S. Coast Guard. Also, guidelines must be drafted for developers who wish to create or revise tools to use with the AutoCAD TSWS.

Conclusions

The AutoCAD workspace has two main attributes. First, the specialized discipline interfaces with customized tools make it easier for users to prepare design documentation. Second, the standards support and its close connection with the TSS provides a reliable means of compliance with the current standards. Because of the system design, standards changes are easy to incorporate. The process of changing to a new standard does not require programming, just running a program to create a new Tri-Service SCIF.

With attention to the descriptions of layers, entire documents may be brought up to standard by running the program with the "fix" option. Third-party programs may be used in conjunction with the AutoCAD workspace to provide productive environments with the added insurance of preparing documentation in compliance with the A/E/C CADD Standards.

This type of workspace should greatly benefit individual users, groups working together, and developers of application programs. New users should find the provided interface intuitive to use and be able to produce standardized documents easily. Users who are familiar with the MicroStation TSWS should find the transition to AutoCAD seamless. More and more, collaboration and sharing are becoming a part of the design process, and an essential part of working as a team is for everyone to comply with the same standards. The uniform environment offered by the Tri-Service Workspace for AutoCAD users should prove to be an advantage to users from different disciplines and organizations.

Reference

Shaw, Doris Smith, Jerry M. Lagrou, Kate R. Millburg, "Tri-Service Workspace for AutoCAD Users," Miscellaneous Paper CADD-97-1 (U.S. Army Engineer Waterways Experiment Station, January 1997).

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13. ABSTRACT ***(Maximum 200 words)***

The U.S. Army Corps of Engineers has undertaken the task of implementing a workspace for AutoCAD that will satisfy the functional requirements found in a 1996 user study. The major goal is to provide an environment to facilitate the production of computer-aided design and drafting (CADD) documents that comply with the Tri-Service graphic standards. The workspace must ensure that users are updated as standards change, and it must work concurrently with existing and newly created CADD software tools. It is also important to provide an intuitive, discipline-specific interface for those who do not choose to use add-on software. The workspace should support the user's needs for checking compliance with the standards and for updating nonstandard design files. The program has been designed so that the necessary updating and compatibility may be provided with as little maintenance cost as possibile.

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